What is claimed is:

1. An adaptive packet transmission method in a cellular mobile communication system using a multibeam satellite, comprising the steps of:

a) being periodically reported, from mobile stations, of average receiving power levels of beam pilot signals transmitted in a plurality of beams;

b) estimating a path gain between beams and the mobile station based on the reported average power levels of beam pilot signals;

c) determining priorities for packets to be transmitted to each of the mobile stations;

d) selecting a beam requiring the lowest transmission power for transmitting the packet having the highest priority, and allocating the lowest power required for satisfying a predetermined packet reception quality when the packet is transmitted in the selected radio resource, by using the path gain estimated for each of the mobile stations; and

e) if the radio resources and/or the transmission power that can be used are not sufficient or if there is a packet to be allocated, performing the step c).

2. The method as recited in claim 1, wherein the beams adjacent to the mobile station belong to an active beam set including a primary beam having the largest average received signal-to-noise-and-interference ratio (SINR) of a pilot

signal and a beam corresponding to a pilot signal whose pilot signal-to-noise-and-interference ratio is larger than or equal to a value obtained by multiplying a fixed rate smaller than 1 by the largest pilot SINR.

3. The method as recited in claim 1, wherein in the step b), the path gain between the mobile station and the adjacent beam is estimated based on a ratio of the pilot transmission power to the average received power of the pilot signal reported from the mobile station.

4. The method as recited in claim 1, wherein the radio resource is divided into a predetermined number of frames,

wherein in a time domain, each frame is divided into one or more time slots, a beam signal is transmitted over multi-carrier; in a frequency domain, each frame is divided into one or more frequency slots, a signal is being transmitted over multiple subcarriers; and in a code domain, each frame is divided into one or more spreading codes, a signal is transmitted using a spreading code, and

wherein each frame is divided by a combination of two or three of the frame division methods.

5. The method as recited in claim 1, wherein the packet allocation is performed based on service requirements, and the packet allocation includes reserved allocation and shared allocation,

wherein in case of a service using the reserved allocation, radio resources required for transmitting the packet are allocated in each frame when the service is established initially, and if there is an additional packet to be transmitted, reserved radio resources are used allocated by the shared allocation, and

wherein the radio resources are selected among the radio resources that not used for the other reserved allocation in the current frame.

6. The method as recited in claim 1, wherein in the step c), when the transmission priority for packet is determined, the radio resources are allocated in the order of high to low priority of the packet to be transmitted, the priority of each packet to be transmitted is calculated based on an equation as:

$$w_{u,k} = (c_u)^{a1}(\gamma_{u,pilot})^{a2}(1/\bar{\gamma}_{u,pilot})^{a3}(1+t_{current}/t_{k,deadline})^{a4}$$

where c_u denotes the service class of the user u,

$\gamma_{u,pilot}$ denotes a received pilot SINR of a primary beam for a user u,

$\bar{\gamma}_{u,pilot}$ denotes an average pilot of the primary beam for the user u,

$t_{current}$ denotes the current time,

$t_{k,deadline}$ denotes the maximum tolerable waiting time of packet k required for satisfying the quality of service, and

the exponents of a1, a2, a3 and a4, which are arbitrary positive real number, are parameters for controlling the dependency on the articles when the packet transmission priority is determined.

7. The method as recited in claim 6, wherein when the transmission priority is determined, the priority of the packet for the reserved allocation service has a larger value than the priority of the packet for the shared allocation service, and the priority of the packets, which are additionally requested other than the packets transmitted using the reserved radio resources in the reserved allocation service, is equal to the priority of the packet for the shared allocation service.

8. The method as recited in claim 7, wherein when the transmission priority is determined, the packet has a high priority in order of re-transmission packets for the reserved allocation service, new transmission packets for the reserved allocation service, re-transmission packets for the shared allocation service and new transmission packets for the shared allocation service.

9. The method as recited in claim 1, wherein the radio

resources are used to transmit each packet, and a radio resource having the largest gain-to-interference ratio (GIR) is selected, the GIR is defined by an equation as:

$$\tilde{\phi}_{u,(b,s,l,m)} = \frac{\tilde{g}_{b,u}}{\tilde{I}_{b,u,(s,l)} + \tilde{Z}_{b,u,(s,l)} + N_{noise}}$$

wherein $\tilde{I}_{b,u,(s,l)} = k_1 \sum_{(b,s,l,i) \in V_{(B,S,L)}, i \neq m} p_{b,s,l,i)} \tilde{g}_{b,u}$,

$$\tilde{Z}_{b,u,(s,l)} = k_2 \sum_{j \in B_b,\, j \neq b} \sum_{(j,s,l,i) \in V_{(j,s,l)},\, i \neq m} p_{j,s,l,i)} \tilde{g}_{j,u} + k_3 \sum_{j \in B_b,\, j \neq b} p_{(j,s,l,m)} \tilde{g}_{j,u}$$, and

B_b denotes a set of beams adjacent to a beam b.

10. The method as recited in claim 9, wherein when considering a gain-to-interference-and-noise ratio (GINR), the radio resources are selected among the beams that belong to the active beam set or to the radio resources of a primary beam.

11. The method as recited in claim 9, wherein in order to calculate the GINR of the radio resources quickly, a set of interfering beams is restricted to a set of beams neighboring to the beams to which the radio resources belong.

12. The method as recited in claim 9, wherein if the same

orthogonal spreading code is shared between the beams, the range of selectable radio resources is restricted to the radio resources that satisfy a condition of re-using an orthogonal code, the condition being expressed by an equation as:

$$\lambda_{SC} \geq \frac{\widetilde{Z}_{b,u,(s,l,m)}}{\widetilde{I}_{b,u,(s,l)} + \widetilde{Z}_{b,u,(s,l)}}$$

wherein $\widetilde{Z}_{b,u,(s,l,m)}$ denotes interference from other beams using the same code in the same frequency/time slot, which is defined as:

$$\widetilde{Z}_{b,u,(s,l,m)} = k_3 \sum_{j \in B_b, j \neq b} p_{(j,s,l,m)} \widetilde{g}_{j,u} .$$

13. The method as recited in claim 1, wherein the transmission power is calculated repeatedly based on the power allocation method expressed by an equation as:

For $n = 1,2,....,N_{itr} - 1$

$$p_{(b,s,l,m)}(n+1) = \gamma_u^* \frac{/SF}{\widetilde{\phi}_{u(b,s,l,m)}(n)}, \quad (b,s,l,m) \in V_{(s,l)}$$

wherein N_{itr} denotes the repetition number,

$V_{(s,l)}$ denotes a set of RRUs that belong to frequency

/time slot (s,l), and

$$\tilde{\phi}_{u,(b,s,l,m)}(n)=\frac{\tilde{g}_{b,u}}{\tilde{I}_{b,u,(s,l)}(n)+\tilde{Z}_{b,u,(s,l)(n)}+N_{noise}},$$

$$\tilde{I}_{b,u,(s,l)}(n)=k_1\sum_{(b,s,l,i)\in V_{(b,s,l,i)}\, i\neq m}p_{b,s,l,i)}(n)\tilde{g}_{b,u}$$, and

$$\tilde{Z}_{b,u,(s,l)}(n)=k_2\sum_{j\in B_b,\, j\neq b}\ \sum_{(j,s,l,i)\in V_{(j,s,l)},\, i\neq m}p_{(j,s,l,i)}(n)\tilde{g}_{j,u}+k_3\sum_{j\in B_b,\, j\neq b}p_{(j,s,l,m)}(n)\tilde{g}_{j,u}.$$

14. The method as recited in claim 1, wherein the transmission mode of radio resources is one selected from one or more transmission modes which are combinations of modulation mode and encoding mode; and the radio resources are allocated using one of the transmission modes as a basic transmission mode in a predetermined case, and if there are usable radio resources but the power is not sufficient to perform the basic transmission mode, a transmission mode having a low transmission rate is used to transmit the selected packet, or if the usable radio resources are not sufficient but the power can be used sufficiently, a transmission rate having a high transmission rate is used to obtain additional radio resources and transmit a packet selected by the additional radio resource to a user having the largest GIR.

15. The method as recited in claim 1, wherein the step b) includes the steps of:

b1) updating the active beam set for each user based on the measurement report on pilot SINR transmitted from each user periodically, and updating the path gain for each user based on the reported pilot signal power;

b2) giving a packet transmission priority value in the order of a group of re-transmission packets for the reserved allocation service, a group of new transmission packets for the reserved allocation service, a group of re-transmission packets for the shared allocation service, and a group of additional transmission packets for the reserved allocation service and new transmission packets for the shared allocation service, calculating priority values for the packets in the same group except the packets belonging to a service for which radio allocation attempt is failed in the current frame, and selecting a packet having the largest priority value;

b3) if no packet is selected, stopping the radio resource allocation process in the current frame, or if there is a selected packet and the selected packet is for the reserved allocation service, allocating radio resources in the reserved allocation method to transmit the selected packet;

b4) if there is a selected packet and the selected packet is a packet requesting additional packet transmission which requires more radio resources than the reserved radio resources or if the selected packet is for the shared allocation service, allocating radio resources in the shared allocation method to transmit the selected packet;

b5) if the radio resources are allocated successfully,

ruling out the packet corresponding to the allocated transmission amount from subsequent allocations, and performing the step b2);

b6) if the radio resources allocation in the reserved allocation method is failed, not attempting the radio resource allocation for the service any more in the current frame, and performing the step b2); and

b7) if the radio resources allocation in the shared allocation method is failed, not attempting the radio resource allocation for the service any more in the current frame, and performing the step b2,

wherein the priority of the packet is calculated based on an equation expressed as:

$$w_{u,k} = (c_u)^{a1}(\gamma_{u,pilot})^{a2}(1/\bar{\gamma}_{u,pilot})^{a3}(1+t_{current}/t_{k,deadline})^{a4}$$

wherein c_u denotes the service class of the user u,

$\gamma_{u,pilot}$ denotes a received pilot SINR of a primary beam for the user u,

$\bar{\gamma}_{u,pilot}$ denotes an average SINR value of the primary beam for the user u,

$t_{current}$ denotes the current time,

$t_{k,deadline}$ denotes the maximum tolerable waiting time of packet k required for satisfying the quality of service, and

the exponents of a1, a2, a3 and a4, which are arbitrary

positive real number, are parameters for controlling the dependency of each component when determining the packet transmission priority.

16. The method as recited in claim 15, wherein the step b4) includes the steps of:

b4-1) if the allocation is performed for the first time for the service to which the packet selected in the current frame belongs, using the transmission mode selected for the service as a basic transmission mode, or if the allocation for the transmission of packet is not the first allocation, using the transmission mode selected in the prior allocation;

b4-2) selecting a radio resource having the largest GINR and not allocated yet among the radio resources reserved for the service of the selected packet;

b4-3) if there is no such radio resources having the largest GIR and not allocated yet, regarding the reserved allocation for the selected packet as a failure, and attempting allocation for the packets which are not allocated for the service according to the subsequent radio resource allocation by the shared allocation method;

b4-4) if there is the radio resource having the largest GINR and not allocated yet, establishing the transmission power for the radio resource that belongs to the same slot as the selected radio resource but already allocated, including the transmission power for the selected radio resource;

b4-5) checking if the sum of total power allocated in the

time slot, which includes the transmission power for the selected radio resource and the transmission power allocated for other radio resources belonging to the same time slot as the selected radio resource, is not more than the maximum available power;

b4-6) if the sum of the total power allocated in the time slot is not more than the maximum power, confirming the selected radio resource allocated for the transmission of the selected packet and the change in the transmission power for the existing radio resources that belong to the same slot as the selected radio resource;

b4-7) if the sum of the total power allocated in the time slot exceeds the maximum power and another radio resource is already allocated for the service in the current frame, not attempting to allocate any radio resource for the service in the current frame;

b4-8) if the sum of the total power allocated in the time slot exceeds the maximum power and the allocation is performed for the first time in the current frame for the service, establishing the transmission power for the radio resource that belongs to the same slot as the selected radio source and is allocated already, including the transmission power for the selected radio resource, in consideration of using a transmission mode having a low transmission rate as a transmission mode for the service in the current frame temporarily;

b4-9) checking whether the sum of the total power

allocated in the time slot, which includes the transmission power for the selected radio resource and the transmission power allocated for another radio resource that belongs to the same time slot as the selected radio resource, is not more than the maximum available power, performing the step b4-8) until the summation is not more than the maximum power or radio resources are allocated in a transmission mode having the lowest transmission rate available;

b4-10) if the sum of the total power allocated in the time slot is not more than the maximum power in the step b4-9), confirming the transmission mode and power selected by the selected radio resource, and the transmission power for the radio resource that belongs to the same slot as the selected radio resource and is already allocated; and

b4-11) if the sum of the total power allocated in the time slot is more than the maximum power even in the transmission mode having the lowest transmission rate available in the step b4-9), not attempting to allocate any radio resource for the service in the current frame.

17. The method as recited in claim 1, wherein the step b5) includes the steps of:

b5-1) if the allocation is performed for the first time for the service to which the packet selected in the current frame belongs, using the transmission mode selected for the service as a basic transmission mode, or if the allocation is not the first allocation for the service to which the packet

selected in the current frame belongs, using the transmission mode selected in the prior allocation;

b5-2) selecting a radio resource having the largest GIR and not allocated yet among the radio resources available in the current frame;

b5-3) if there is the radio resource having the largest GINR and not allocated yet, establishing the transmission power for the radio resource that belongs to the same slot as the selected radio resource but is already allocated, including the transmission power for the selected radio resource;

b5-4) checking if the sum of the total power allocated in the time slot, which includes the transmission power for the selected radio resource and the transmission power allocated for another radio resource that belongs to the same time slot as the selected radio resource, is not more than the maximum available power;

b5-5) if the sum of the total power allocated in the time slot is not more than the maximum power, confirming the selected radio resource allocated for the transmission of the selected packet and the change in the transmission power for the existing radio resources that belong to the same slot as the selected radio resource;

b5-6) if the sum of the total power allocated in the time slot exceeds the maximum power and another radio resource in the current frame is already allocated for the service, not attempting to allocate a radio resource any more in the

current frame for the service;

b5-7) if the sum of the total power allocated in the time slot exceeds the maximum power and the allocation is performed for the first time in the current frame for the service, establishing the transmission power for the radio resource that belongs to the same slot as the selected radio source and is allocated already, including the transmission power for the selected radio resource, in consideration of using a transmission mode having a low transmission rate as a transmission mode for the service in the current frame temporarily;

b5-8) checking whether the sum of the total power allocated in the time slot, which includes the transmission power for the selected radio resource and the transmission power allocated for another radio resource that belongs to the same time slot as the selected radio resource, is not more than the maximum available power, and performing the step b5-7) until the sum of the total power allocated in the time slot is not more than the maximum power or radio resources are allocated in a transmission mode having the lowest transmission rate available;

b5-9) if the sum of the total power allocated in the time slot is not more than the maximum power in the step b5-8), confirming the transmission mode and power selected by the selected radio resource, and the transmission power for the radio resource that belongs to the same slot as the selected radio resource and is already allocated;

b5-10) if the sum of the total power allocated in the time slot is more than the maximum power even in the transmission mode having the lowest transmission rate available in the step b5-8), not attempting to allocate a radio resource for the service any more in the current frame;

b5-11) if there is no such radio resource that has the largest GIR and is not allocated yet among the radio resources available in the current frame in step b5-2), selecting a service that has the largest GINR in the radio resource already allocated in the current frame and does not use a transmission rate having the highest transmission rate available;

b5-12) if there is no such service, not attempting allocation for the service to which the packet selected in the current frame belongs;

b5-13) if there is such service, temporarily establishing a transmission mode having a high transmission rate as a transmission mode for the service, re-adjusting the radio resource used for the service, and using a transmission mode having a higher transmission rate than the preceding transmission modes until non-used radio resource should exist or a transmission mode having the highest transmission rate is used;

b5-14) if there is no non-used radio resource until the transmission mode having the highest transmission rate is used at step b5-13), not attempting allocation for the service to which the selected packet belongs any more in the current

frame;

b5-15) if there is a non-used radio resource, establishing the transmission power for the established allocation, the transmission mode for which is adjusted, including the transmission power for the transmission of the selected packet in the non-used radio resource;

b5-16) checking if the sum of the total power allocated in the time slot, which includes the transmission power for the selected radio resource and the transmission power allocated for another radio resource which belongs to the same time slot as the selected radio resource, is not more than the maximum available power, and if the summation of the transmission power for the radio resource whose transmission mode is adjusted and the transmission power allocated for another radio resource that belongs to the same time slot is not more than the maximum available power;

b5-17) if the sum of the total power allocated in the time slot is not more than the maximum power, confirming the allocation for packet transmission in the selected radio resource and the allocation for packet transmission in the radio resource, the transmission mode for which is adjusted; and

b5-18) if the sum of the total power allocated in the time slot is more than the maximum power, performing the step b5-13).

18. A computer-readable recording medium for recording a

program executing an adaptive packet transmission method in a cellular mobile communication system using a multibeam satellite for, the adaptive packet transmission method comprising the steps of:

a) being periodically reported, from mobile stations, of average receiving power levels of beam pilot signals transmitted in a plurality of beams;

b) estimating a path gain between beams and the mobile station based on the reported average power levels of beam pilot signals;

c) determining priorities for packets to be transmitted to each of the mobile stations;

d) selecting a beam requiring the lowest transmission power for transmitting the packet having the highest priority, and allocating the lowest power required for satisfying a predetermined packet reception quality when the packet is transmitted in the selected radio resource, by using the path gain estimated for each of the mobile stations; and

e) if the radio resources and/or the transmission power that can be used are not sufficient or if there is a packet to be allocated, performing the step c).